A FELLODISTOMID CERCARIA FROM *MYTILUS PLANULATUS*

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Synopsis

The large furcocercous cercaria of a fellodistomid trematode is reported from the mussel, *Mytilus planulatus*, in New South Wales. Apart from its size, this cercaria is unusual in having an almost fully developed reproductive system and in the possession of intestinal caeca of unequal length. These and other details of morphology differentiate this cercaria from others previously recorded from this family. The larva is described and named *Cercaria praecox* n. sp.

Introduction

In Sydney Harbour and on the south coast of New South Wales the mussel, *Mytilus planulatus* Lamarck, 1819 is occasionally infected with the larval stages of a fellodistomoid trematode. The visceral mass and gonad of infected mussels are packed with sac-like sporocysts, usually bright orange, in which develop large furcocercous cercariae. This infection of mussels is rare in Sydney Harbour, only four of more than one thousand *Mytilus* examined over two years being infected, and the cercariae have been found in only one of four areas sampled so far. This is at " The Spit " in Middle Harbour. A low rate of infection in mussels collected near Bateman's Bay on the New South Wales south coast has been reported by Dr. M. J. Howell (personal communication). These larvae have been found before, as wholemounts of sporocysts and cercariae labelled " Fork Tailed Cercaria, *Mytilus* sp., Sydney Harbour, 1932 ", are in the Parasitology Museum, School of Public Health and Tropical Medicine, Sydney. No other details of this earlier collection are known, and as there is no published description, the larva is described here and named *Cercaria praecox* n. sp., with reference to its advanced state of gonad development.

Materials and Methods

The description is based on sporocysts and cercariae dissected from mussels and examined both alive in seawater and as wholemounts fixed with hot 70% alcohol then stained with Gower's carmine, and on serial sections cut at 9μm. from infected host tissue. Twenty-seven larvae, selected for their advanced state of development, were measured, and all measurements are, unless stated otherwise, from living cercariae flattened under a coverslip and are in millimetres. The values stated in the text are the minimum and maximum obtained for each character measured.

Description

Distome, non-ocellate, furcocercous cercaria developing in simple sporocysts in the visceral mass and gonad of *Mytilus planulatus*. Sporocysts bright orange, cercariae white. Body of cercaria aspinose, contractile, varying from elongate to globose. Body length of specimens measured unflattened; extended 1·90–2·10, contracted 0·20–1·0; body width, extended 0·19–0·20, contracted 0·40–0·70. Oral sucker wider than long, 0·25–0·60×0·24–0·41; ventral sucker at centre of body, circular, 0·15–0·28 diameter. Mouth terminal; no prepharynx; pharnyx large, length 0·14–0·30, width 0·14–0·24; oesophagus extending past ventral sucker; caeca thick walled with blind ends, that of the right side extending to the end of the body, that of the left side half way only.

Groups of gland cells in region of oral sucker, beside pharynx, and in lateral fields and centre of body behind ventral sucker. Details of ducts not determined.

Reproductive system well developed. Testes ventral, just posterolateral to ventral sucker; oval, 0·09–0·18 × 0·50–0·13; cirrus sac 0·21–0·42 × 0·10–0·14, containing bipartite seminal vesicle, unspined cirrus and prostatic cells; situated

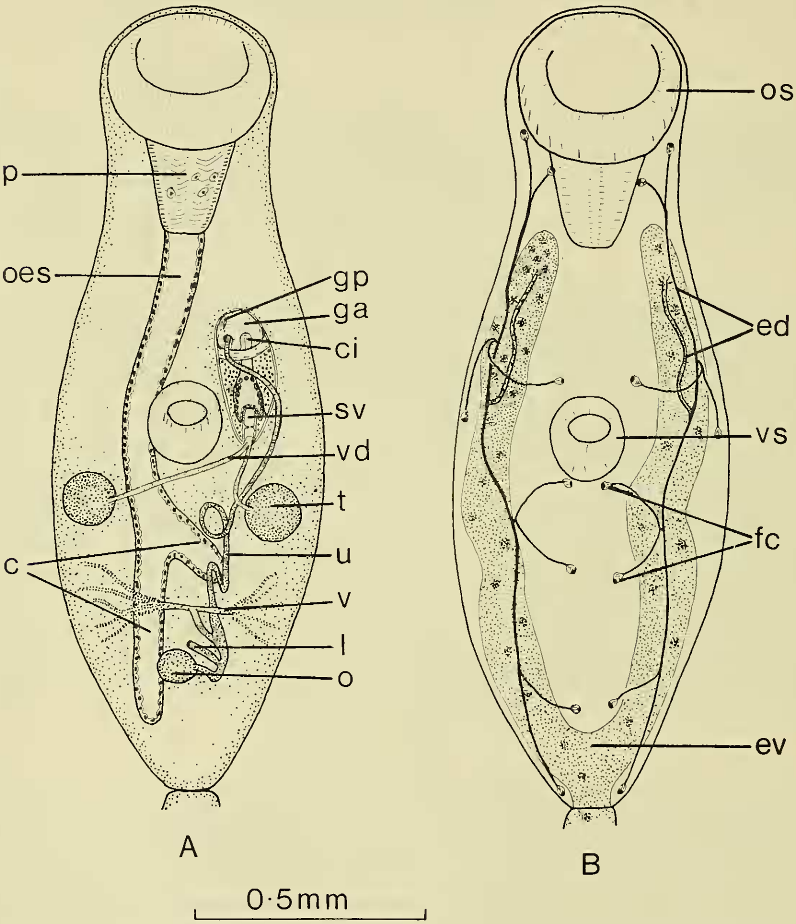

Fig. 1. *Cercaria praecox* n. sp. (A) Body of cercaria, ventral view showing intestine and reproductive system. Specimen flattened under a coverslip resulting in displacement of organs such as cirrus sac, which is normally vertical. (B) Body of cercaria, ventral view showing excretory system.

Abbreviations for Text-figures

c—caeca.	oes—oesophagus.
ci—cirrus.	os—oral sucker.
ed—excretory duct.	p—pharynx.
ev—excretory vesicle.	sv—seminal vesicle.
fc—flame cell.	t—testis.
ga—genital atrium.	u—uterus.
gp—genital pore.	v—primordium of vitelline glands.
l—laurer's canal.	vd—vas deferens.
o—ovary.	vs—ventral sucker.

slightly to left of and anterior to ventral sucker, bending ventrally to open into genital atrium from above. Ovary posterior to testes and just anterior to excretory vesicle, entire, circular to oval, $0 \cdot 08–0 \cdot 18 \times 0 \cdot 04–0 \cdot 13$. Laurer's canal present, short, opening on dorsal surface near ovary. Uterus with several coils in post-testicular area, extending anteriorly to open ventrally into genital atrium. Primordia of vitelline glands in lateral fields at level of ovary, with a racemose pattern of collecting ducts.

Excretory vesicle thin walled, lyre-shaped, with long arms ; protonephridium stenostomate ; recurrent tubule ciliated, extending back to region of ventral sucker, where it receives an anterior and a posterior collecting tubule, each of which is joined to two groups of two flame cells. The excretory formula is, therefore, $2[(2+2)+(2+2)]$. A muscular sphincter opens into a single caudal tubule extending from the excretory vesicle to the furcae, where it divides ; excretory pores at tips of furcae. Excretory vesicle and tail of some older specimens filled with refractile concretions.

Tail length to fork in unflattened specimens 1·33–3·30, width 0·13–0·16 ; furcal length 0·79–1·60.

Sporocysts simple, sac-like ; broader posteriorly, narrowing to anterior tip, where birth pore is situated. Length of largest specimens after fixation and staining 3·0.

Host : *Mytilus planulatus* Lamarck, 1819.

Localities : Sydney Harbour and the south coast of N.S.W.

Type Material : School of Public Health and Tropical Medicine, Sydney. Reg. No. MN1663.

Discussion

Holliman (1961), in a checklist of known marine cercariae, mentioned 20 species of fork-tailed fellodistomid cercariae, and in the same article described four new species, thus bringing the total number known at that time to 24.

Nineteen of these larvae are ascribable to the Dichotoma group of cercariae, minute larvae with spinose bodies and short intestinal caeca which rarely extend past the ventral sucker, considered by Cable (1953) to be larvae of the Gymnophallinae. The adults of this group lack a cirrus sac and have compact vitellaria situated in the mid-line, near to the ventral sucker. The genital pore is also median. *Cercaria praecox* n.sp. differs in each of these characteristics, and presumably the adult form of this larva is distinct from the adults of the Gymnophallinae.

The cercaria of *Fellodistomum felis* Nicoll, 1909, which develops in the bivalve *Nucula tenuis* (Montagu), differs from *C. praecox* in being smaller (cercarial body $0 \cdot 59 \times 0 \cdot 36$), in having a short oesophagus and caeca of equal length, and in not reaching the same stage of gonad development in the molluscan host. Whilst the vitelline follicles of most of the Fellodistominae, including *F. felis*, are anterior to the ventral sucker, in *C. praecox* two groups of cells which are presumably the primordia of the vitellaria are situated in the lateral fields at the level of the ovary, which is posterior. Little change in the position of organs is likely during growth to the adult, as the larva is already very advanced in development.

Three other furcocercous larvae, *C. haswelli* Dollfus, 1927, *C. kenti* Dollfus, 1927, and *C. mathiasi* Dubois, Baer and Euzet, 1952, possess the characters of the genus *Tergestia* Stossich, namely 13 muscular lobes arranged in a circle, incomplete ventrally, around the oral sucker, and six paired cuticular folds on the sides of the forebody. The tails of these cercariae are dilated proximally, forming an organ considered to be a pneumatophore (Angel, 1960). *C. praecox* lacks all these characters and differs also from the larvae of *Tergestia* in having intestinal caeca of unequal length and in the arrangement of the gonads.

The cercaria of the genus *Haplocladus* described by Rees (1947) is similar to *C. praecox* in a number of respects, particularly the excretory system, but has an unbranched intestine and testes placed in tandem, lateral to the excretory bladder near the posterior end of the body.

Four subfamilies of the Fellodistomidae were recognized by Cable (1953). These were: Fellodistominae Nicoll, 1909; Gymnophallinae Odhner, 1905; Haplocladinae Odhner, 1911; and Tandanicolinae Johnston, 1927. Dollfus (1947) maintained, and Yamaguti (1953) accepted this view, that *Monascus* Loos, 1907 has priority over *Haplocladus* Odhner, 1911 and that the correct subfamily name is Monascinae.

Cable (1954) stated that the primitive condition in the Fellodistomidae is furcocercous, but that this has been altered along several lines. Thus cercariae related phylogenetically may differ greatly in the development and morphology of the tail. Expression of relationship between fellodistomid cercariae should, consequently, be based on the morphology of the body and on knowledge of life histories. *C. praecox* n. sp. is more representative of the Monascinae than of any other of the subfamilies of the Fellodistomidae. The intestine, with its long oesophagus and unequal length caeca placed behind the ventral sucker, could be considered an intermediate stage between a form with equal length caeca and *Monascus* with an unbranched intestine. Although the flame cell pattern of the Fellodistomidae is variable and the same pattern may be found in quite different genera, the formula of *C. praecox* $2[(2+2)+(2+2)]$, is found in three genera of the Monascinae: *Monascus*, *Tergestia*, and *Proctoeces*.

Though it is similar to the Monascinae, *C. praecox* is clearly not congeneric with any of the members of that subfamily, and further clarification of its taxonomic position depends on the finding of other stages in the life cycle. Several fellodistomid life cycles are known, and these may provide guidelines in the search for the adult of *C. praecox*.

Metacercariae of *Proctoeces* are known to be progenetic in their molluscan second intermediate hosts (Stunkard and Uzmann, 1959; Dollfus, 1964), and are probably able to dispense with the definitive host, a fish, though the abnormal host conditions result in frequent loss of fertility. *C. praecox* reaches an advanced stage of gametogeny in the molluscan host, spermatids being present in the testes of large cercariae, and requires only to pass through the stages of egg-shell formation and vitellogenesis, and oviposition to reach sexual maturity, and it may possibly have a life cycle similar to that described by Stunkard and Uzmann (1959) for *Proctoeces maculatus*. However, such a large, inactive larva as *C. praecox* would more probably be ingested by either a second intermediate host or the definitive host. No cercariae have been seen to leave the infected mussels in the laboratory and those larvae released by dissection have shown no tendency to swim, but instead sink to the bottom, where they lie, contracting and expanding the body and coiling and uncoiling the tail (Fig. 2). In the dissected mussels, cercariae and sporocysts were carried by ciliary currents and ejected, and this would presumably happen to cercariae emerging from sporocysts under natural conditions, though larvae of some Gymnophallinae are known to develop as unencysted metacercariae between the mantle and shell of bivalves (Holliman, 1961). Cercariae which emerged from or were ejected from mussels would sink to the bottom or into the mass of weed and sponges lower down on the wharf piles where infected mussels have been found. In this situation detritus feeders such as crabs or ophiuroids would be likely second intermediate hosts. Chubrik (1952) described the life cycle of *Fellodistomum felis* in which an ophiuroid, *Ophiura sarsi* Lutken, acts as second intermediate host. The ophiuroid is eaten by a fish and the adult fluke develops in the gall-bladder and bile ducts. Bottom-feeding fish which eat invertebrates could possibly be the definitive host of *C. praecox*. Similarly, fish, such as Toados (Ovoididae) and Porcupine-fish (Diodontidae), which eat mussels, could also be the definitive host of this cercaria.

Stunkard and Uzmann (1959) suggested that fish acquire infection with species of *Proctoeces*, which are progenetic in bivalves, by eating the infected molluscs. This situation could lead to false host records for some trematodes, as a fish examined soon after ingesting an infected mussel would contain apparently mature adult flukes in its intestine.

It is probable that the adult of *C. praecox* n. sp., when found, will bear close relationship to the Monascinae, possibly constituting a new genus in that subfamily.

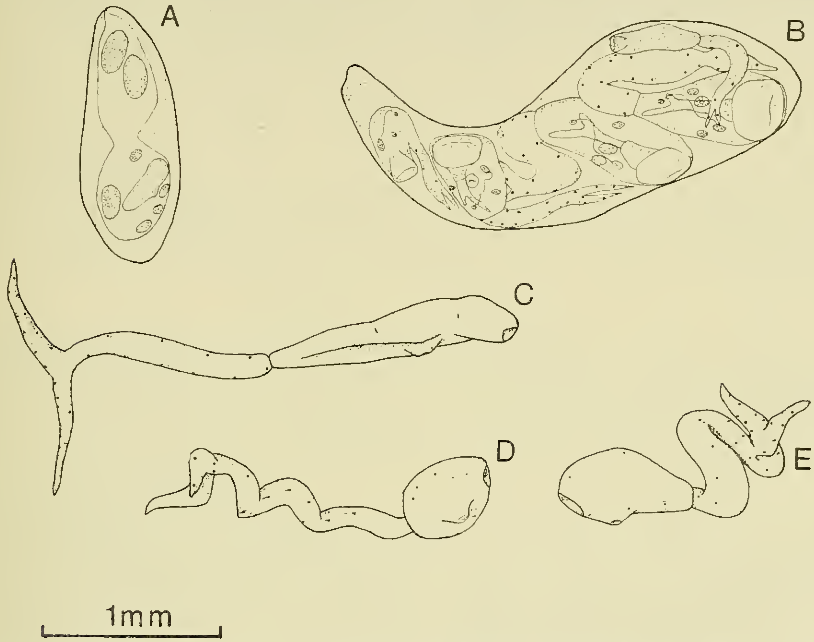

Fig. 2. *Cercaria praecox* n.sp. (A) Young sporocyst containing germ balls and developing cercaria. (B) Mature sporocyst containing mature and developing cercariae. (C) Cercaria in extended position. (D), (E) Cercariae with bodies contracted and tails coiled.

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